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Transactive Memory and Performance in Work Groups: Specificity, Communication, Ability Differences, and Work Allocation

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The present study examined the effects of specificity, communication, ability differences, and work allocation, on the utilization of transactive memory in work groups. Clerical staff members ($N = 36$) worked individually and then with a coworker to complete a quiz covering six domains of work-related knowledge and to allocate domains of knowledge or specific quiz items in a manner that maximized group performance. Allocations were made first individually and then collaboratively. Results indicated that transactive memory facilitated group performance. Specificity (item allocations vs. domain allocations) led to more effective utilization of member knowledge, but communication did not. Group performance was higher when members differed in ability and when they allocated more work to the more proficient member.

Keywords: transactive memory, recognition of expertise, group performance, communication

This study examines transactive memory (a shared knowledge system for learning, storing, and retrieving information) in work groups. Transactive memory can lead to the development of complementary patterns of specialized knowledge that expand the total amount of knowledge available to members of a work group. For example, if Megan is having a software problem but knows that Sue is an expert with the software and is willing to help, this allows Megan access to the requisite knowledge. Likewise, Sue may need information about travel policies that Megan can provide. This study extends previous work by examining: (a) whether explicit communication is important for the effective utilization of transactive memory, (b) the specificity with which transactive memory can be used to allocate work among group members, and (c) the relations between member knowledge, work allocation, and performance gains derived from transactive memory.

Previous Research on Transactive Memory

Although transactive memory was first applied to the study of close relationships (Wegner, 1987; Wegner, Erber, & Raymond, 1991), a number of studies have examined transactive memory in work groups. They suggest that transactive memory systems can develop naturally when people work together and can lead to higher levels of group performance when group members solve problems together.

In a series of experiments with groups of students building radios, Moreland and colleagues (Liang, Moreland, & Argote, 1995; Moreland, 1999) found that groups that trained

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together developed transactive memory systems that led to higher levels of group performance. Likewise, Littlepage, Robison, and Reddington (1997) found that groups of students who had previously worked with the same group members on a closely related task were better able to recognize member expertise and that this facilitated group performance. In a laboratory study in which students completed a series of electronic assembly tasks, Lewis, Lange, and Gillis (2005) found that transactive memory facilitated group performance and influenced group learning and transfer to related tasks.

Hollingshead (2000) found that perceptions of coworker's expertise affected the strategy members used to learn work-related knowledge in an attempt to maximize collective performance. Individuals recalled more words from their own areas of expertise when paired with someone who had different domains of expertise, but when paired with someone with similar domains of expertise, people tended to recall words from outside their expertise. Thus, members utilized their knowledge of patterns of member expertise to select a strategy to enhance group performance.

Although Hollingshead (2000) sampled workers from an organizational setting, the study did not involve the use of intact work groups and focused on individual strategy rather than group performance. Although laboratory studies of temporary work groups (Lewis et al., 2005; Liang et al., 1995; Littlepage et al., 1997; Moreland, 1999) did examine group performance, they did not utilize natural work groups. A few recent studies have examined transactive memory in natural work groups in organizational settings.

Faraj and Sproull (2000) studied expertise coordination in intact software-development teams. They found that team member's knowledge of areas of member expertise was related to both effectiveness (e.g., meeting project goals, meeting design objectives) and efficiency (adhering to schedule and budget). Thus, they demonstrated that a key component of transactive memory is closely linked to effective group performance in organizational work groups.

Both Austin (2003) and Lewis (2003, 2004) studied transactive memory in organizational groups. Austin (2003) examined transactive memory in management teams responsible for making key decisions concerning product lines. Measures of amount of task knowledge, consensus about member expertise, accuracy of transactive memory, and knowledge specialization were derived from self- and other ratings of expertise in various task domains. Each of these components of transactive memory was positively related to goal attainment and managerial ratings of group performance. Lewis (2003) studied transactive memory in MBA student consulting groups and in work teams (consisting mostly of engineers) in high-technology companies. Scales were developed to measure three manifestations of transactive memory: knowledge specialization, perceived credibility of member expertise, and coordination of knowledge processing. Across both studies, these measures of transactive memory were positively related to ratings of team performance.

The current study extends previous research by examining factors that may affect the extent of performance improvement when groups allocate work based on transactive memory. An initial step was to establish that the groups had transactive memory systems that allowed for performance improvement. Based on previous findings that transactive memory systems develop in intact work groups and facilitate performance, we propose the following.

> *Hypothesis 1:* Members of established work groups will have a transactive memory system that facilitates group performance. Following Austin's conceptualization of transactive memory (2003) we measured various components of transactive memory: member agreement about who knows what, knowledge specialization, accuracy, and utility (performance improvement).

Communication

At least three communication processes are important to transactive memory: directory updating, communication to allocate information, and communication to retrieve information (Hollingshead, 1998b; Palazzolo, 2005; Wegner, 1995). Directory updating is a key process in the development of transactive memory. It involves learning the types of information that other members know. Although persons can learn about patterns of member expertise in

other ways (Moreland & Myaskovsky, 2000), directory updating is generally accomplished through communication between group members (Hollingshead & Brandon, 2003; Palazzolo, 2005). Communication to allocate information involves forwarding information to persons who have been deemed as experts. Communication to retrieve information involves acquiring needed information from a person who has been deemed as an expert. These processes are involved in the utilization of an existing transactive memory system (Palazzolo, 2005).

To understand the role of communication in transactive memory fully, it is important to distinguish between the development and the utilization of transactive memory. Communication between members typically plays a major part in the *development* of transactive memory (Hollingshead & Brandon, 2003; Lewis, 2004; Liang et al., 1995; Rulke & Rau, 2000). For example, in a study of student consulting teams, Lewis (2004) found that the extent of face-to-face communication was positively related to the development and refinement of transactive memory.

Research concerning the role of communication in the *utilization* of shared knowledge is not entirely consistent. Although communication can enhance the effectiveness of utilization of an existing transactive memory system (Hollingshead, 1998b; Palazzolo, 2005), it does not appear to be essential. Studies of groups encoding new information show that groups with a shared understanding of patterns of member knowledge can allocate responsibility to members in a manner that increased group performance, and can do so without explicit communication (Hollingshead, 2000, 2001; Wegner et al., 1991). Likewise, studies of tacit coordination suggest that, without communication, groups can use their expectations about member expertise to coordinate task assignment in a way that facilitates performance (Vaughan & Stasser, 1996; Wittenbaum, Stasser, & Merry, 1996; Wittenbaum, Vaughan, & Stasser, 1998).

> *Hypothesis 2:* In established work groups, transactive memory can facilitate performance in the absence of explicit communication. Thus, we expected performance improvements deriving from transactive memory even when members could not explicitly communicate to coordinate member responsibilities.

Specificity

Transactive memory involves the association of categories of knowledge to individual group members. Member expertise is regarded as hierarchically organized, with specific areas of knowledge nested within broader domains (Brandon & Hollingshead, 2004; Wegner, 1987, 1995). Although transactive memory has been studied at both the broad level (e.g., Hollingshead, 2000; Liang et al., 1995) and at the specific level (e.g., Hollingshead, 1998b; Wegner et al., 1991), no studies have directly examined the effect of specificity of transactive memory on group performance. In a review and synthesis of transactive memory research, Austin and Hanke (2006) noted the distinction between global and specific measures of expertise and suggested that research is needed to understand the implications of different measurement strategies more fully. Likewise, Palazzolo (2005) noted the need to examine both broad and specific knowledge domains to determine the most appropriate level of granularity on which to focus.

Various lines of theory and research indicate the importance of assigning work responsibilities in a manner that utilizes member expertise (Hackman, 1987; Littlepage et al., 1997; Littlepage, Schmidt, Whisler, & Frost, 1995; Steiner, 1972; Stempfle, Hubner, & Badke-Schaub, 2001). Assigning work responsibilities to individual group members based on a shared global assessment of general areas of member expertise can lead to a rough fit between member knowledge and skills and task demands. However, if the more expert group member does not know everything within his or her knowledge domain and another member possesses some complementary knowledge within that domain, it is likely that allocation of responsibilities at a specific rather than a more global level can lead to a more complete utilization of member knowledge and improve the level of group performance.

Steiner (1966) suggested that on complementary (divisible) tasks, less-expert members can provide nonredundant information that allows group performance to exceed the level of the best member. Research comparing group per-

formance and best-member performance on such tasks indicates that groups can outperform the best member (Laughlin, Zander, Knievel, & Tan, 2003; Michaelsen, Watson, & Black, 1989; Tindale & Larson, 1992). For example, Olson and Davis (1964) studied group and individual performance on a task requiring the solution of five math problems and found that 64% of the groups correctly completed the five-problem set, greatly exceeding the best-member baseline of 15%. This suggests that within a general domain of knowledge, persons who are not the most expert member can still contribute specific knowledge that can facilitate group performance. It follows that a shared understanding of member knowledge will allow for more effective utilization of member expertise and result in greater performance benefits when members are able to make specific rather than general work allocations.

> *Hypothesis 3.* Transactive memory systems operate more effectively at an item level than at a domain level. That is, allocation of specific quiz items to group members will result in a greater performance advantage than allocation of larger content domains.

Ability Differences

Although studies of *general cognitive* ability do not show a consistent relationship between ability heterogeneity and performance (Devine & Philips, 2001), some evidence suggests that heterogeneity of levels of *task-specific* ability may be positively associated with performance on some types of tasks (G. L. Stewart, 2006). For example, using a multi-item reasoning test, Laughlin, Branch, and Johnson (1969) found that groups with heterogeneous levels of ability showed higher levels of performance than homogeneous groups. Because appropriate task assignment may be more critical when members differ substantially in ability levels, transactive memory may be especially useful when ability differences are large. Because expertise is more effectively recognized when large differences in ability levels exist (Baumann & Bonner, 2004), it is likely that large differences in ability levels will lead group members to assign a larger workload to the more competent member. Therefore we propose the following hypotheses.

> *Hypothesis 4.* The size of the performance benefits deriving from transactive memory will be greater when group members have large differences in the level of task-related knowledge.

> *Hypothesis 5.* A positive relation exists between the share of the workload allocated to the more competent member and ability heterogeneity.

Method

Overview

Pairs of coworkers from the same department completed instruments assessing areas of perceived work-related knowledge of self and coworker. They were informed that they would complete a job-knowledge quiz and were instructed to assign different parts of the quiz to specific members. Only the designated person's answers would count toward a group score, and the goal was to maximize the group score. First, they allocated broad domains of job knowledge to self and coworker and later they allocated specific quiz items to self or coworker. The domain allocations and the item allocations were made both individually and collaboratively.

Participants

Like Hollingshead (2000), we utilized pairs of administrative and secretarial staff members. Thirty-six secretarial staff members (18 pairs) participated; all were female, and the mean age was 47.83 ($SD = 6.72$). At a large university in the southeastern United States, we identified academic departments employing at least two secretaries or other administrative or clerical staff members. The secretarial staff members from these departments were recruited through e-mails and follow-up face-to-face recruitment. The e-mail indicated that each participant would need to pair up with another clerical staff member from the same department and that both would need to participate at the same time. Half of the participants were from departments with only two secretaries; the others were from departments with three or four secretaries. Each participant was given a $25 gift certificate to participate and was eligible for additional $25

gift certificates for outstanding individual or group performance on a test of job knowledge.

Materials

In collaboration with the first author, a subject-matter expert constructed a multiple-choice quiz covering six knowledge domains that department-level clerical staff members would encounter on the job: travel procedures, computer screens for scheduling, payroll forms, campus assistance to students, campus assistance to employees, and office software. The expert was a Certified Professional Secretary who had been working at the university for over 20 yr. Each domain contained five questions, for a quiz total of 30 questions. For example, the travel domain included items such as "Where on the Internet can you check reimbursement rates (lodging, meals, & incidentals) for out-of-state travel?" and "Which form should be completed before travel takes place?"[1]

Procedure

Each pair of coworkers was tested together in a separate experimental session. A female experimenter provided a brief description that the study was concerned with the ability of coworkers to work effectively as a group. Instructions indicated that the purpose of the study was to look at how work-group members specialize in different parts of the job. She remained in the room for the entire study to provide instructions, distribute materials, and ensure that participants followed the specified procedures. The procedure consisted of several steps, with participants working alone, and also as a pair. In Step 1, participants were welcomed and given a sheet with definitions of each knowledge domain. This was done to introduce and define the six domains of knowledge that were utilized in the study; participants could refer to this sheet throughout the study. Each participant completed a brief task of matching six sample items (not included in the quiz) to domains. This served as a check to ensure the participants' understanding of the nature of the knowledge domains. The mean number of matches was 5.5 out of 6 (SD = 1.03), indicating that participants understood the meaning of the domains. The researcher provided feedback to each group and corrected any errors to ensure further that the participants understood the nature of the knowledge domains.

In Step 2, each participant completed an assigned-responsibility checklist in which she identified the formal division of labor in her group for each of the six knowledge domains. In Step 3, each participant individually rank-ordered the six knowledge domains in terms of her knowledge. In Step 4, each participant individually ranked her coworker's proficiency in the six content domains.

In Step 5, participants were informed that each would independently take a quiz covering the six content domains. Each participant was told to allocate individually three domains for herself and three for her coworker in a manner that would maximize the group quiz score. (That is, the score for a domain would be the number of items correctly answered by the person to whom the domain had been assigned; the six domain scores would be totaled to yield a quiz score for the group).

In Step 6, the two participants met as a group and reached consensus about the allocation of content domains, three to each participant. Their goal was to reach consensus on the allocation of content domains in a way that would maximize the group score. For Step 7, each participant individually took the quiz covering the six content domains. While taking the test, each member answered the questions, but also chose whether she or her coworker (self or other) would best answer each item. The goal was to assign items to each group member so that the group score was maximized.

At Step 8, the participants reviewed the quiz questions as a group and reached consensus on who would be best suited to answer each question. They were allowed to discuss whether they felt confident to answer the item or otherwise indicate who they thought should take the item, but they were instructed not to discuss specific answers. In order to ensure that specific answers were not discussed, participants were provided with a sheet listing the questions, but not the answers, and were instructed not to discuss how they had answered the questions. For both individual and group allocation of items (Steps 7 and 8), participants were not constrained to al-

[1] The quiz may be obtained from the first author.

locate the same number of items to each participant.

In Step 9, each participant individually completed a brief work processes questionnaire. This provided information about the working relationships between coworkers.

Measures

A number of dependent measures were utilized. They are described below and calculations are illustrated in the Appendix.

Member agreement. Agreement about the areas of job knowledge provides evidence of the group's transactive memory. Three indices were available to assess coworker agreement: domain rank agreement, domain allocation agreement, and item allocation agreement. *Domain rank agreement* reflects the extent to which coworkers agreed on each person's proficiency across the six content domains. Each person's set of self-rankings of proficiency in the six knowledge domains (Step 3) was correlated with the set of rankings she received from her coworker (Step 4). For each pair of coworkers, these correlations were averaged (using r to z transformation) to yield a group-level measure of domain rank agreement. *Domain allocation agreement* represents the correspondence (proportion of matches) between the coworker's (individual) assignments of domains to one of the two individuals (Step 5). Proportion of coworker agreement on the (individual) allocation of items between the two coworkers (Step 7) represents *item allocation agreement*.

Specialization. The following steps led to a measure of specialization of expertise, the extent to which group members displayed complementary patterns of expertise. For each domain, performance scores were standardized. Within each group, correlations were computed between the standardized performance scores of the two members across the six content domains. Negative correlations provide evidence of specialization. In addition, two items from the work processes questionnaire provide measures of perceived specialization (specialization of job duties and work skills).

Accuracy. Two approaches were used to assess accuracy of transactive memory, yielding a measure of *ranking accuracy* and various measures of *allocation accuracy*. For ranking accuracy, each group member's ranking of her expertise (Step 3) and the ranking of her expertise provided by her partner (Step 4) were reversed (so that high scores would indicate greater proficiency). For each content domain, the reversed self-ranking and partner ranking were averaged to yield a measure of the group's assessment of the member's expertise in each of the content domains. For each content domain, this average was paired with the member's standardized performance and a correlation was computed to reflect agreement between perceived and actual expertise across the six content domains. For each group member, this correlation was converted to a z score and averaged across group members to yield a group-level measure that represents the extent to which the group's ranking of member expertise across the six domains corresponds to actual member expertise.

The following steps were used to derive measures of allocation accuracy. The individual and collective allocations of domains (Steps 5 and 6), along with the individual quiz scores in each knowledge domain (Step 7) were used to create two performance scores based on allocation of domains. The *individually allocated domain-level performance score* and the *group-allocated domain-level performance score* provided indices of group performance when using domain-level transactive memory. Group-allocated domain-level performance was calculated by summing (across the six domains) the number of items correctly answered by the person to whom the group had allocated responsibility for that domain. Individually allocated domain-level performance was calculated for each participant based on her individual allocations, then averaged across the two coworkers to yield a single measure for each pair of coworkers. Similar indices were calculated (Steps 7 and 8) to reflect performance based on individual and group allocation of items: *individually allocated item-level performance score* and *group-allocated item-level performance score*.

These four performance scores were used to develop four indicators of the accuracy of transactive memory. Each was obtained by comparing performance based on domain (or item) assignments consistent with allocations and performance obtained if the domains (or items) were assigned to the person not chosen by the group (the person thought to be less competent). If members share an accurate understanding of

the areas of strengths and weaknesses of member's knowledge, then performance based on group (or individual allocations) should exceed performance based on assignments inconsistent with these allocations.

Utility. If groups allocated domains without the aid of an effective transactive memory system, they would be expected to perform at the level of the average member. Performance improvements resulting from the allocation of domains or items to specific group members provide evidence of the utility of transactive memory. Four indices of utility were utilized. They reflect the performance advantage (allocated performance minus average member performance) resulting from individual or group allocation of domains and from individual or group allocation of items.

Results

Because the study was designed to examine transactive memory in intact work groups, we examined data from the work processes questionnaire (Step 9) to determine whether the pairs of secretaries not only worked in the same department, but also had an opportunity to gain an understanding of patterns of coworker knowledge. Most pairs had been working in the same department for some time: 92% for 6 months or more, and 44% for at least 4 years. Participants indicated how frequently they discussed work-related issues with the coworker; 94% indicated discussing work with the coworker at or above the midpoint of the scale ("sometimes"). Each participant rated the extent of her knowledge of the coworker's work skills; 89% of responses were at or above the midpoint of the scale ("some knowledge"). These findings suggest that the group members interacted and had some knowledge of the coworker's work skills.

Correlations between performance scores on the six domains averaged .22 and ranged from −.25 to .58. This suggests that, for the most part, the domains tapped relatively independent aspects of job knowledge as we had intended.

Existence of a Transactive Memory System

Agreement. Three indices were available to assess coworker agreement about the areas of relative strength and weakness of each member: domain rank agreement, domain allocation agreement, and item allocation agreement. All three indices suggest that there was substantial agreement among coworkers. Analysis of *domain rank agreement* revealed a mean correlation of .63, and that the group members agreed at a greater than chance level (zero correlation); $t(17) = 5.80$, $p < .01$, $r^2 = .66$. A single-sample t test was used to compare the proportion of *domain allocation agreement* to a chance level of agreement (50% agreement). Coworkers agreed ($M = .74$; $SD = .24$) at a level greater than chance;; $t(17) = 4.19$, $p < .01$, $r^2 = .51$. Coworkers also agreed on allocation of items; the proportion of *item allocation agreement* ($M = .73$, $SD = .16$) was greater than chance level; $t(17) = 6.25$, $p < .01$, $r^2 = .70$. These indices provide support that coworkers had at least a moderate level of agreement about each member's areas of expertise.

Although our findings suggest the presence of transactive memory, an alternative explanation should be considered. If members share an understanding of the *overall* amount of task-relevant knowledge possessed by each member and have a shared understanding of the difficulty of the various tasks, they may assign the harder tasks to the more proficient member. Although this could lead to agreements about task allocations and might improve performance, it would not involve the use of transactive memory because it would not involve the knowledge of the *patterns* of strengths and weaknesses of various members. To investigate this alternative explanation, we examined the within-group correlation between the two group members' pattern of self-rankings of expertise. If some tasks were considered to be easier, then both members should rank these as among their strongest areas of knowledge, resulting in a high positive correlation between the domain rankings of the two coworkers. For each group, the correlation between the coworker's domain rankings was computed and transformed to a z score for analysis. The mean score was .24 ($SD = 1.06$), was equivalent to a correlation of .23, and was not significantly different from zero; $t(17) < 1$, *ns*. This indicates that group members did not share a common view of the relative difficulty of the various content domains. Thus, the high level of coworker agreement on measures of domain rank agreement

and domain allocation agreement was not simply the result of a common assessment of the difficulty of the various domains. Rather, it seems that coworker agreement about domain rankings and allocation of domains and items reflects the operation of transactive memory.

The level of agreement observed at the item level ($M = .73$) is similar to the level of agreement observed at the domain level ($M = .74$). This suggests that the shared understanding of member knowledge operated at both general and specific levels. The correspondence of the domain allocations and item allocations was examined by comparing the assignment of specific items to the assignment of the domain represented by that item. Correspondence was 74% for allocations made by interactive groups and 69% for individual allocations. Regardless of whether allocations were made jointly or independently, the coworkers tended to assign items consistent with the domain allocations, but made some adjustments when assigning specific items.

Specialization

Two items from the work processes questionnaire provided evidence of perceived specialization. Using a scale anchored by *very similar* (coded 1) and *very different* (coded 7), participants rated the extent of differentiation between self and partner with respect to work skills and job duties. For work skills, the mean rating was 4.19 ($SD = 1.86$), and 53% of the responses were above the midpoint. The mean rating for job duties was 4.69 ($SD = 1.95$), and 64% of the ratings were above the midpoint. The pattern of ratings indicates that group members perceived a moderate degree of specialization with respect to job skills and duties.

We also examined the extent of actual specialization of expertise as indicated by patterns of performance across knowledge domains. Within-group correlations between the coworker's patterns of expertise across domains were computed. Positive correlations indicate similar patterns of member knowledge and negative correlations reflect specialization. The groups showed a great deal of variability; correlations ranged from −.69 to .97. Two-thirds of the correlations were negative; the median correlation was −.27. The mean correlation, $r(16) = -.08$, did not approach significance. These data suggest an intermediate level of specialization. Member expertise was not concentrated in the same domains, but there was not a strong degree of specialization.

Accuracy

Multiple measures of the accuracy of transactive memory were developed. One measure was derived from individual rankings of member knowledge of the content domains, and four indices were derived from allocation of domains or items to group members. The measure of *ranking accuracy* represents the extent to which the pattern of member ranking of expertise across domains is consistent with the pattern of expertise across domains. The mean of the transformed within-group correlations (mean $z = .20$, $SD = .33$) reflects a modest degree of accuracy (mean $r = .20$); $t(17) = 2.53$, $p < .05$, $r^2 = .27$.

Four indicators of accuracy are based on the performance difference between domain (or item) assignments that are consistent with allocations and assignments that are inconsistent with allocations. For example, the performance based on group allocations of domains was compared to the level of performance that would have been observed if the score was calculated based on the answers of the person not selected by the group. The *group-allocated domain-level performance scores* (where domain assignments matched group allocations) ($M = 23.50$, $SD = 2.09$) were higher than when domain assignments were contrary to group allocations ($M = 21.67$, $SD = 2.95$), $t(17) = 2.39$, $p < .05$, $r^2 = .34$. A similar pattern was found for individual domain allocations and group and individual item allocations ($r^2 = .26$, .58, and .59, respectively). These five accuracy indices provide consistent support that the shared understanding of member knowledge had some degree of accuracy.

Although groups demonstrated a reliable degree of accuracy, transactive memory was not perfectly accurate. If performance was based on a perfect allocation of domains (such that each person was assigned three domains in a manner to maximize group performance), groups could have achieved a mean score of 25.28 ($SD = 2.11$). This represents a higher level of performance than was achieved by either group ($M = 23.50$; $SD = 2.09$), $t(17) = -5.40$, $p <$

.01, $r^2 = .63$, or individual domain allocations ($M = 23.36$; $SD = 2.15$); $t(17) = -6.69$, $p < .01$, $r^2 = .74$.

Allocation of items also indicated a moderate, but less than perfect, degree of accuracy. Across groups, both members were correct on 60.19% of the items, one member was correct on 30.00% of the items, and both members were incorrect on 9.81% of the items. Of the items correctly answered by only one group member, the group allocated 73.46% to the more proficient member. Single-sample *t* tests indicated that this was greater than chance accuracy—$t(17) = 2.45$, $p < .01$, $r^2 = .26$—but less than perfect accuracy; $t(17) = 3.50$, $p < .01$, $r^2 = .42$. Examination of the performance based on group allocations indicated that 55.21% of the errors were due to lack of available information (neither member was correct), and 44.79% were due to allocation errors (allocating the item to the incorrect member when the other member answered the item correctly). Across multiple measures, findings suggest that the groups had less than perfect, but moderately accurate transactive memory systems.

Utility

Performance scores represent the number of items from the 30-item quiz that were answered correctly. We examined the utility of transactive memory by comparing performance based on the allocation strategies used by participants with performance that would have been observed by a random pattern of allocation. The individually allocated domain-level performance scores ($M = 23.36$, $SD = 2.15$) exceeded the average individual performance scores; $M = 22.56$, $SD = 2.01$; $t(17) = 2.50$, $p < .05$, $r^2 = .27$. Likewise, group-allocated domain-level performance [$M = 23.50$, $SD = 2.09$, $t(17) = 2.44$, $p < .05$, $r^2 = .26$], individually allocated item-level performance [$M = 24.44$, $SD = 1.95$, $t(17) = 4.94$, $p < .01$, $r^2 = .59$] and group-allocated item-level performance [$M = 24.61$, $SD = 2.28$, $t(17) = 4.99$, $p < .01$, $r^2 = .59$] exceeded average individual performance. These findings provide evidence that a shared understanding of member knowledge resulted in higher levels of group performance.

Findings for agreement, specialization, accuracy, and utility provide support for Hypothesis 1. These secretarial groups had transactive memory systems that facilitated group performance. Findings of the utility of individual domain allocations and individual item allocations provide support for Hypothesis 2 that communication is not required for the effective utilization of transactive memory.

Specificity and Communication

We examined two factors that might affect a group's ability to utilize transactive memory effectively to maximize group performance: the ability of members to explicitly communicate to make collective allocations, and the specificity by which tasks could be allocated to group members (Hypothesis 3). Because individual allocations were made without interaction and group allocations were made jointly, the contrast between performance based on these two types of allocation provides a means to assess the impact of communication and collaborative allocation. The comparison of performance based on domain versus item allocations provides an indication of whether transactive memory systems operate only at the level of general categories of knowledge or whether they also involve more detailed types of knowledge.

The effects of communication and specificity on quiz performance were analyzed with the use of a 2 × 2 repeated-measures ANOVA (individual vs. group allocations by domain vs. item level). A significant main effect was observed for specificity (domain vs. item level); $F(1, 17) = 8.59$, $p < .01$, $\eta^2 = .29$. This reflects a *specificity advantage*, higher performance with item allocations than with domain allocations. There was not a significant main effect for communication, $F(1, 17) < 1$, *ns*, or an interaction effect, $F(1, 17) < 1$, *ns*. The nonsignificant main effect for communication (individual- vs. group-allocated performance) provides additional evidence concerning Hypothesis 2. It suggests that, for intact work groups with an extensive history of communication, explicit communication to allocate tasks does not substantially enhance a group members' ability to utilize an existing transactive memory system effectively.

The significant specificity effect is consistent with Hypothesis 3 and suggests that groups performed at a higher level when they had

greater flexibility in terms of information allocation. It may be that the specificity advantage (greater performance when item allocations were possible vs. domain-level allocations) is a result of the greater precision of assigning tasks to match member knowledge (cf. Brandon & Hollingshead, 2004). However, another possibility exists, the assignment of a greater workload to the more competent member.

Ability Differences and Work Allocation

Comparison of the performance (number of correct answers) of the more and less proficient member of each pair of coworkers indicated that pairs of coworkers tended to differ in levels of expertise; $t(17) = 5.77$, $p < .01$, $r^2 = .66$. Performance differences ranged from 0 to 10 items correct ($M = 4.67$, $SD = 3.43$).[2] The items were not assigned equally, $t(17) = 6.87$, $p < .01$, and more of the 30 quiz items were assigned to the more proficient group member ($M = 18.38$ items, $SD = 3.59$); $t(15) = 3.76$, $p < .01$, $r^2 = .45$. Consistent with Hypothesis 5, as the ability difference between the two members increased, so did the tendency to assign items on an unequal basis, $r(16) = .60$, $p < .01$, and to assign more items to the more proficient member, $r(14) = .60$, $p < .05$.

Hypothesis 4 predicted that the utility of transactive memory would be greater when members differed in the extent of task-specific knowledge. Ability heterogeneity was positively related to the utility of both individual item allocations, $r(16) = .80$, $p < .01$, and group item allocations, $r(16) = .60$, $p < .01$. However, ability heterogeneity was not related to either individual domain allocations, $r(16) = .03$, *ns*, or group domain allocations, $r(16) = .21$, *ns*. This provides partial support for Hypothesis 4: Ability heterogeneity is related to utility of transactive memory when work allocation can be made at a specific level, but not when global allocations are made.

Additional analyses were conducted to examine two factors that might enhance the understanding of the specificity advantage (the greater utility of item allocations than domain allocations): ability differences and unequal workload. Ability heterogeneity may contribute to the specificity advantage because the opportunity to assign knowledge responsibilities strategically to utilize the expertise of the more competent member may be greater with specific than with global allocations. The potential impact of unequal workload on the specificity effect reflects the fact that allocation of domains to group members was constrained (each member was assigned three domains), but item allocations were not constrained in this manner and more items were assigned to the more competent member. For individual allocations, the specificity advantage was related to ability heterogeneity, $r(16) = .69$, $p < .01$, but was not significantly related to the number of items allocated to the more proficient member, $r(14) = .35$, *ns*. Likewise, for group allocations, the specificity advantage was related to ability heterogeneity, $r(16) = .45$, one-tailed $p < .05$, but not to the number of items allocated to the best member, $r(14) = .38$, *ns*.

Regression of the specificity advantage (performance based on item allocations minus performance based on domain allocations) on both ability heterogeneity and greater allocation to the best member indicates that ability heterogeneity was the more powerful predictor. For individual allocations, R^2 (2, 13) = .44, $p < .05$, ability heterogeneity predicted the specificity advantage ($b = .71$, $p < .05$), whereas greater allocation of items to the best member did not ($b = -.07$, *ns*). For group allocations, R^2 (2, 13) = .27, *ns*, neither predictor was significant, but the weighting for ability heterogeneity was somewhat larger ($b = .44$) than for allocation pattern ($b = .12$). Regression of utility of item-level allocations (performance based on allocation of items minus average individual performance) on these predictors also indicates that ability difference was a more important predictor than the number of items allocated to the more knowledgeable member. For utility based on average individual allocation of items, R^2 (2, 13) = .65, $p < .01$, ability heterogeneity was a better predictor ($b = .97$, $p < .01$) than greater allocation to the best member ($b = -.36$, *ns*). For utility based on group allocation of items, R^2 (2, 13) = .28, *ns*, ability heterogeneity ($b = .63$, $p = .053$) was a stronger predictor than allocation to the best member ($b = -.21$, *ns*).

[2] For two groups, the two coworkers displayed the same level of performance on the job knowledge quiz. These groups were excluded from analyses involving allocation of items to the more proficient coworker.

The pattern of correlations and regression weights suggest that the utility of transactive memory with specific allocations and the specificity advantage are more closely related to ability differences than to unequal workload allocation.

Discussion

Existence of Transactive Memory

Consistent with Hypothesis 1, findings support the existence of transactive memory systems that facilitate performance in established work groups of clerical workers. Group members had a shared and accurate understanding of the areas of member expertise that facilitated group performance.

Coworker ratings of differentiation of work skills and duties indicated that the coworkers perceived a moderate degree of specialization. An examination of patterns of member knowledge indicated that although coworkers did not display a high level of specialization, neither did they show a strong tendency for duplication of knowledge. These findings suggest an intermediate level of specialization. Lewis (2003) found that workers from the same department showed less specialization of expertise than members of cross-functional and management teams. It is possible that the relatively routine nature of the work performed by functional groups of front-line workers may exert pressures toward standardization of work duties and worker knowledge that may limit the extent of knowledge specialization.

Results based on multiple indices indicate that the transactive memory systems were moderately accurate. The finding of a moderate level of accuracy of the transactive memory systems is consistent with results from management groups; Austin (2003) reported a mean accuracy score of 3.56 on a 5-point scale, reflecting a moderate level of accuracy of transactive memory. The findings that transactive memory systems are only moderately accurate suggests that it might be worthwhile to seek ways to improve accuracy of member knowledge. Provision of outcome feedback improves the recognition of member expertise even when the best member varies across content areas (Henry, Strickland, Yorges, & Ladd, 1996). Similarly, providing members with a shared understanding of areas of member expertise results in greater discussion and utilization of member knowledge (Stasser, Stewart, & Wittenbaum, 1995; Stewart & Stasser, 1995). Thus, the present findings and findings from related research raise the possibility that focused discussions of work knowledge and preferences, job shadowing, or other interventions may have the potential to lead to the development of more accurate transactive memory systems.

As predicted, the utilization of transactive memory led to higher levels of group performance. Previous studies utilized two approaches to examine the utility of transactive memory. Some studies have demonstrated that intact groups outperform ad hoc groups (e.g., Hollingshead, 1998b; Lewis, 2003, Study 1; Liang et al., 1995), and that the performance advantage can be accounted for by the existence of transactive memory (Moreland, 1999; Moreland & Myaskovsky, 2000). Other studies (e.g., Austin, 2003; Lewis, 2003, Studies 2 and 3) have used intact groups to investigate the relationship between scores on transactive memory scales and ratings of group performance. The present study employed a different approach. It compared the performance of groups that utilized their transactive memory system to divide responsibility with the level of performance that would be obtained if groups divided responsibility without the aid of transactive memory. Despite differing operationalizations of utility, findings consistently illustrate the performance advantage of transactive memory in work groups.

Our findings that organizational work groups developed reasonably accurate and useful transactive memory systems are consistent with previous research (e.g., Austin, 2003; Faraj & Sproull, 2000; Lewis, 2003). These previous studies of transactive memory in organizations utilized groups working in consulting teams, project teams, management teams, or cross-functional teams. These are teams whose main purpose ". . .is to leverage members' expertise to create new knowledge in the form of new products, services, or solutions" (Lewis, 2004, p. 1520). Secretarial groups may be characterized as functional groups because they are composed of members of same professional discipline (Parker, 1994), and also as service groups because they provide a variety of services to faculty and students based on their specific and

varying needs (Devine, 2002; D. J. Devine, personal communication, May 11, 2005; Sundstrom, 1999). The existence of useful transactive memory systems among secretarial groups extends the findings to functional groups of front-line workers. This is an important extension because the work of functional teams differs in a number of ways from that of teams used in previous research on transactive memory within organizations, and because performance benefits of transactive memory are thought to be greater for complex, nonroutine work and with coworkers with diverse knowledge (Brandon & Hollingshead, 2004; Lewis, 2004). Functional teams tend to have shorter work cycles, greater task structure, greater hardware dependence, more specialized physical skills, and greater similarity of member skills than the management, planning, and design groups that have been studied (Devine, 2002). Nevertheless, office staff members perform a variety of tasks including budgeting, archiving, preparing documents, and providing information and services to coworkers and clients (International Association of Administrative Professionals [IAPP], 2005; Occupational Information Network, 2004). These activities require a range of knowledge and skills and members of office teams may have opportunities to utilize transactive memory to improve team performance. Laboratory studies (Lewis, Lange, & Gillis, 2005; Liang et al., 1995; Moreland, Argote, & Krishnan, 1998; Moreland & Myaskovsky, 2000) indicate that transactive memory can facilitate group performance in production groups. Thus, current findings from intact organizational groups support this laboratory work to suggest that the benefits of transactive memory are not limited to management groups and other groups of executives. These findings converge with previous studies to illustrate the performance advantage of transactive memory and suggest that this advantage can occur in a variety of work contexts and with different types of work groups.

Although findings provide strong evidence of the existence of effective transactive memory systems among groups of secretarial staff members, additional research may be warranted to examine a potential limitation. Because some of the pairs of coworkers were recruited from departments with more than two secretarial staff members, a selection bias might have inflated our findings concerning the degree to which coworkers displayed a transactive memory system. It might be worthwhile to investigate whether self-selected pairs of coworkers have a more well-developed transactive memory systems than the work group from which they were drawn.

Communication

Previous research with romantic couples has examined effects of communication on transactive memory (e.g., Hollingshead, 1998a; 1998b). However, this study was the first study of work groups to manipulate the level of communication and examine its impact on the utilization of transactive memory. Consistent with Hypothesis 2, findings suggest that explicit communication is not critical to the *utilization* of an existing transactive memory system. This conclusion is consistent with previous research showing that groups with an established transactive memory system can allocate responsibility for learning new information in a manner that increased group performance and they can do this without communication (Hollingshead, 2000, 2001; Wegner et al., 1991) and with studies of tacit coordination (Vaughan & Stasser, 1996; Wittenbaum et al., 1996, 1998).

Our findings indicated that performance did not differ between group allocations (that allowed communication between group members) and individual allocations (that did not allow communication). Although these findings suggest that explicit communication to allocate tasks does not affect performance, one should not conclude that communication is not important in transactive memory. The importance of communication in the development of transactive memory is well documented (Hollingshead & Brandon, 2003; Lewis, 2004; Palazzolo, Serb, She, Su, & Contractor, 2006; Yoo & Kanawattanachai, 2001). Furthermore, the lack of a communication effect does not rule out the importance of communication for transactive retrieval. For example, Palazzolo (2005) found that group members communicate to retrieve information from others whom they perceive as experts. What the lack of a communication effect does suggest is that for intact work groups with a history of working together, additional communication at the time of task allocation over and above the background level of com-

munication that naturally occurs does not improve performance.

Although the lack of a communication effect is consistent with some studies (Hollingshead, 1998a), it differs from Hollingshead (1998b). Both the present study and Hollingshead (1998b) involved the retrieval of previously acquired information, but Hollingshead found that communication increased the utility of transactive memory and that mutual gaze, cueing, discussion of shared experiences, comparing answers, and demonstrating that one's answer is correct improved performance. A possible reason for the differing results could be the depth of discussion in the collaborative conditions. In Hollingshead's study, group members were allowed to discuss their answers to each quiz item, whereas in the present study, members were not allowed to discuss their specific answers to each question, just the amount of confidence each partner had in her answer. Because, in the present study, members did not discuss their answers to the questions, the communication processes identified by Hollingshead may have been much less useful. This analysis is consistent with research on group recognition memory suggesting that member exchange of task-relevant information facilitates group performance (Clark, Hori, Putnam, & Martin, 2000). Likewise, procedures that increase the depth of discussion, such as reaching consensus about the most relevant pieces of information (Henry, 1995) and rank ordering alternatives (Hollingshead, 1996) led to more complete utilization of member knowledge. Nevertheless, additional research that focuses on transactive memory is needed to verify this interpretation that depth of discussion moderates the impact of communication on transactive retrieval.

Specificity

The present study was the first to compare the effectiveness of domain- and item-level transactive memory systems. Examination of performance based on both domain allocations and on item allocations indicated that the use of transactive memory resulted in performance above the level of the average group member. This indicates that, regardless of whether allocations are made at a specific (item) or at a more general (domain) level, transactive memory can positively affect group performance. The utility of domain-level allocations suggests that transactive memory can facilitate effective performance when group members divide responsibilities for broad categories of the group's work. That is, transactive memory may lead to more appropriate formal and informal role assignment.

Although allocation of domains improved performance, performance was higher when allocations were made at the more specific item level than at the more general domain level. This *may* indicate that transactive memory can lead to greater performance benefits when tasks can be allocated at a specific level. Because specific allocations can lead to more precise matching of worker knowledge to task demands, this interpretation is consistent with previous theory and findings on the importance of utilization of member expertise (Hackman, 1987; Littlepage et al., 1997). Although this interpretation is plausible and is consistent with Hypothesis 3, it is also possible that the greater benefit of item allocations may reflect a greater assignment of work to the more competent member. Domain allocations were constrained to require that each member had an equal number of domains, but item allocations allowed for one member to take on a greater share of the work. More items were allocated to the more proficient member. The decision not to require equal allocation of items was based on an attempt to minimize the complexity of the allocation task faced by participants, and it also provided an element of realism, because work allocation in organizations may also be unequal. However, it raised the possibility that unequal assignment is a key factor accounting for the greater accuracy with item allocations. Because greater assignment of items to the best member had a moderate, but nonsignificant, correlation with the specificity advantage (r = .38 and r = .35 for group and individual allocations, respectively), we cannot fully discount the effects of unequal work allocations. Because unequal work allocations may be common and because they may raise concerns about equity, additional research on transactive memory that examines the benefits and liabilities of unequal work allocation would be valuable.

Although unequal allocation may have an impact on the specificity advantage, analyses of ability heterogeneity suggest that more effective

recognition and utilization of member expertise may be more critical. Regression analyses indicated that difference in the ability levels of the two coworkers was a stronger predictor of the specificity effect than was unequal allocation of items. Likewise, heterogeneity of ability level was closely associated with item-level utility scores ($r = .80$ and $r = .60$, respectively, for individual and group allocations) and to the specificity advantage ($r = .69$ and $r = .45$ for individual and group allocations, respectively) but not domain-level utility scores. The impact of ability heterogeneity on group performance stems from its impact on recognition and utilization of member expertise. Work by Baumann and Bonner (2004) and Libby, Trotman, and Zimmer (1987) indicated that ability heterogeneity resulted in higher levels of group performance because it facilitated the recognition, utilization, and impact of member expertise.

Ability differences lead to performance improvements when groups can recognize and utilize differences in member abilities. Transactive memory allows groups to utilize member expertise more effectively to achieve higher levels of performance. Factors that facilitate recognition and utilization of member expertise, such as specificity and ability heterogeneity, should increase the utility of transactive memory. That is, the specificity advantage may result from the group's ability to make allocations to utilize member expertise more effectively when transactive memory can be used to make specific (rather than global) allocation of work responsibilities. At a theoretical level, this implies that members have knowledge of specific strengths and weaknesses of coworkers that can supplement the more global assessments. At a practical level, this suggests that the performance advantages deriving from transactive memory are greater when group members differ in levels of task-relevant knowledge and when relatively specific work allocations can be made.

Findings suggest that front-line workers can develop a shared understanding of member expertise that can have a positive impact on group performance. Because of organizational trends such as the widespread use of work teams, the use of work teams among front-line employees, and the greater autonomy of many groups (Cohen & Bailey, 1997; Lawler, Mohrman, & Benson, 2001), performance gains from transactive memory among front-line workers can be quite widespread. Findings indicate that transactive memory systems in intact work groups can allow for the tacit coordination of member knowledge that facilitates group performance. The unequal allocation of work responsibility may allow for more effective utilization of transactive memory and highlights this as an area worthy of further study. There is evidence that a broad understanding of patterns of member knowledge can lead to enhanced performance, and there is suggestive evidence that a more detailed understanding of member knowledge may be even more beneficial and that this advantage is especially important when members differ in levels of task-related knowledge.

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Appendix

Calculation of Dependent Measures

Data from the following hypothetical group are used to illustrate the calculation of key dependent variables. Tables A1 and A2 provide data concerning domain rankings, domain allocations, and number of items correctly answered by each group member. This information serves as the basis for demonstrating the calculation of domain-level variables. Table A3 provides item-level data that are used to illustrate calculations of item-level measures.

Domain rank agreement. For Member 1, the self-rankings of proficiency in the six domains (column b) were correlated with the rankings she received from her partner (column c). This yielded a correlation of .771, which was converted to a z value of 1.020. Similar calculations for Member 2 yielded a correlation of .829, $z = 1.188$. The mean of the two z values was 1.104, which corresponds to a mean correlation of .80, the value of the domain rank agreement measure.

Domain allocation agreement. This is the proportion of matches in the allocation of domains by Members 1 and 2 (column f of Tables A1 and A2). Both members agreed on allocations for four of the six domains: travel, payroll, employees, and software. This yielded a value of .67.

Item allocation agreement. This measure is the proportion of matches in the allocation of the 30 items. Table A3 shows the allocation of items. The two group members agreed on 19 of the 30 items, yielding a score of .63.

Specialization. Specialization of expertise was measured by the correlation between the standardized performance scores of Members 1 and 2 (column e of Tables A1 and A2). A negative correlation indicates specialization; for this example, the correlation was −.80.

Ranking accuracy. For each group member, the self-ranking of expertise (column b of Tables A1 or A2), and her ranking of expertise provided by the partner (column c of Tables A1 or A2) were reversed. That is, a rank of 6 was transformed to 1, 5 to 2, and so on, such that high scores indicated areas of greater expertise. For each domain, the two reversed rankings (self and from partner) were averaged to yield a measure of the member's expertise for that domain. For example, for Member 1, the average reversed rankings for the six domains were travel = 1, scheduling = 2.5, payroll = 2.5, students = 4.5, employees = 5.5, software = 5. For each domain, this measure was paired with the member's standardized expertise score (column e of Table A1 or Table A2) and a correlation was computed. The correlation between these two measures represents the correlation between the actual and perceived expertise for this group member. This correlation was .673 for Member 1, and .823 for Member 2. Each correlation was converted to z and averaged; the mean z was transformed to an r to yield a group-level measure that represents the extent to which the group's ranking of member expertise across the six domains corresponds to actual member expertise. The value for the sample data set is .76.

Group-allocated domain-level performance score. This measure was obtained by summing

Table A1
Domain-Level Data for Member 1

a Domain	b Self-rank	c Rank from partner	d Performance	e Standardized performance	f Allocations
Travel	6	6	2	−1.45	M2
Scheduling	4	5	3	−0.57	M1
Payroll	5	4	2	−1.82	M2
Students	3	2	5	1.65	M2
Employees	2	1	4	−0.60	M1
Software	1	3	5	1.46	M1

(*Appendix continues*)

Table A2
Domain-Level Data for Member 2

a Domain	b Self-rank	c Rank from partner	d Performance	e Standardized performance	f Allocations
Travel	1	1	5	1.56	M2
Scheduling	3	4	4	0.28	M2
Payroll	2	3	5	0.99	M2
Students	4	2	3	−0.63	M1
Employees	6	6	4	−0.60	M1
Software	5	5	3	−0.49	M1

(across the six domains) the number of items correctly answered by the person to whom the group collectively allocated responsibility. If the group allocated scheduling, employees, and software to Member 1, and the remaining domains to Member 2, the group-allocated domain score would be 25 items correct (5 for travel from Member 2, 3 for scheduling from Member 1, 5 for payroll from Member 2, three for students from Member 2, 4 for employees from Member 1, and 5 for software from Member 1).

Individually allocated domain-level performance score. This was obtained by calculating a performance score based on the domain

Table A3
Item-Level Data

a Item (domain)	b M1 correct	c M1 allocation	d M2 correct	e M2 allocation	f Group allocation
1 (Travel)	0	M2	1	M2	M2
2 (Travel)	1	M2	1	M2	M2
3 (Travel)	0	M2	1	M2	M2
4 (Travel)	0	M2	1	M2	M2
5 (Travel)	1	M1	1	M2	M2
6 (Scheduling)	1	M1	1	M2	M2
7 (Scheduling)	0	M1	1	M2	M2
8 (Scheduling)	1	M1	1	M2	M2
9 (Scheduling)	0	M2	1	M1	M1
10 (Scheduling)	1	M1	0	M2	M1
11 (Payroll)	0	M2	1	M2	M2
12 (Payroll)	1	M2	1	M2	M2
13 (Payroll)	0	M2	1	M2	M2
14 (Payroll)	0	M2	1	M2	M2
15 (Payroll)	1	M2	1	M2	M2
16 (Students)	1	M2	0	M1	M1
17 (Students)	1	M2	1	M1	M2
18 (Students)	1	M1	1	M2	M2
19 (Students)	1	M2	0	M1	M1
20 (Students)	1	M1	1	M1	M2
21 (Employees)	1	M1	0	M1	M1
22 (Employees)	1	M1	1	M1	M1
23 (Employees)	0	M2	1	M2	M2
24 (Employees)	1	M1	1	M1	M1
25 (Employees)	1	M1	1	M1	M1
26 (Software)	1	M1	0	M1	M1
27 (Software)	1	M2	1	M1	M2
28 (Software)	1	M1	0	M1	M1
29 (Software)	1	M1	1	M1	M1
30 (Software)	1	M1	1	M1	M1

allocations by Member 1 and a performance score based on the allocations by Member 2. In the current example, Member 1's allocations yield performance scores of 25 (5 + 3 + 5 + 3 + 4 + 5; see Table A1, column f) and Member 2's allocations yield a score of 28 (5 + 4 + 5 + 5 + 4 + 5; see Table A2, column f). These two scores were averaged to yield a group-level measure, 26.5 in the current example.

Group-allocated item-level performance score. Each item was scored as correct or incorrect depending on whether the person to whom the group allocated responsibility answered the question correctly. Based on group allocations of items (Table A3, column f) and the items answered correctly by members 1 (Table A3, column b) and Member 2 (Table A3, column d), the group-allocated item-level performance score was 29.

Individually allocated item-level performance score. This measure was obtained by averaging a performance score based on item allocations by Member 1 (Table A3, column c) and a performance score based on item allocations by Member 2 (Table A3, column e). Item allocations by Member 1 yielded a performance score of 27, and item allocations by Member 2 yielded a score of 28. Averaging these two scores resulted in a group-level measure of 27.5.

Allocation accuracy. Four indices of allocation accuracy were developed. Each is based on a comparison of one of the four performance measures (described above) with the level of performance that would have been observed if domains (or items) had been assigned contrary to allocations. Higher performance when domain (or item) assignments were consistent with allocations provides evidence of accurate transactive memory. As indicated above, with the current example performance based on group allocation of domains yielded a score of 25 correct items. Assigning domains contrary to group allocations would result in a performance score of 20. As indicated previously, the individually allocated domain-level performance score was 26.5. Performance based on assigning domains contrary to individual allocations would result in a performance score of 18.5 (mean of 20 for Member 1 and 17 for Member 2).

The previously determined value for group-allocated item-level performance was 29. If items were assigned contrary to group allocations, the performance score would be 16. For individually allocated item-level performance, the performance score was previously shown to be 27.5. Performance based on assigning items to the person to whom they were not allocated would yield a score of 17.5 (mean of 18 for Member 1 and 17 for Member 2).

Utility. Four indices of utility were calculated by subtracting average member performance from each of the four previously defined performance indices (performance based on: group domain-level allocations, individual domain-level allocations, group item-level allocations, and individual item-level allocations). *Average member performance* is calculated by averaging the number of items correctly answered by Member 1 and the number correctly answered by Member 2. In the present example, average member performance was 22.5 (mean of 21 for Member 1 and 24 for Member 2).

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